Naturally-Occurring Radionuclides and the Radionuclide Rule

What You Measure May Not Be What You Want
A Case Study for Poolesville, Maryland

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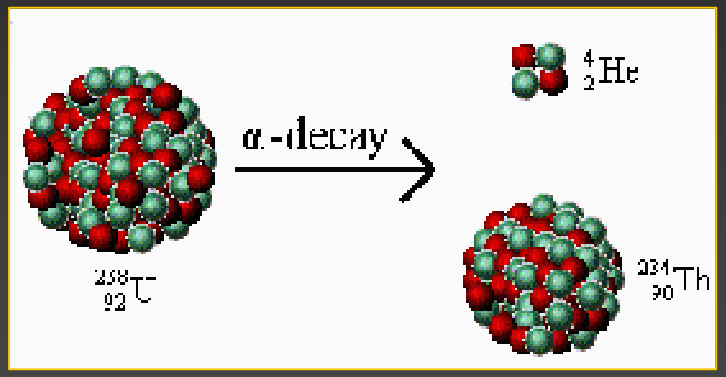
What is a Radionuclide?



- Naturally occurring compound in the aquifer
- Decays and emits radiation
  - Alpha emitters
  - Beta emitters
- Examples include radon, radium, uranium, thorium

EPA Radionuclide Rule - 2000

- Establishes MCLs for
  - Gross alpha particle
  - Uranium
  - Radium
  - Beta/photon emitters
- Applies to all Community Water Systems
- A catch-all approach – i.e., *cast a big net and let them sort it out*

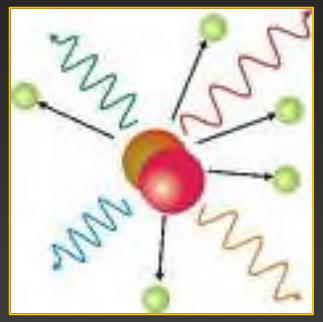
Gross Alpha Particle MCL

- 15 pCi/L
- If uranium-bearing minerals in aquifer, likely exceed MCL
- Rule allows removal of U contribution to gross alpha activity
- Adjusted Gross Alpha activity MCL of 15 pCi/L = Measured gross alpha activity – Uranium activity

Adjusted Gross Alpha Activity

- Analyze for gross alpha activity using EPA method 900.0
- Analyze for uranium

Two Ways to Measure Uranium



- Measure the radioactivity produced by uranium in the water sample (reported as activity, pCi/L)

- Measure the mass of uranium in the water sample (reported as concentration, ug/L)

Uranium and the Alpha MCL

- Uranium often analyzed using ICP-MS method – EPA 200.8
  - Lab may report U results in both ug/L and pCi/L
- Measures U mass (ug/L)
- Must convert mass (ug/L) to activity (pCi/L) to evaluate adjusted gross alpha MCL

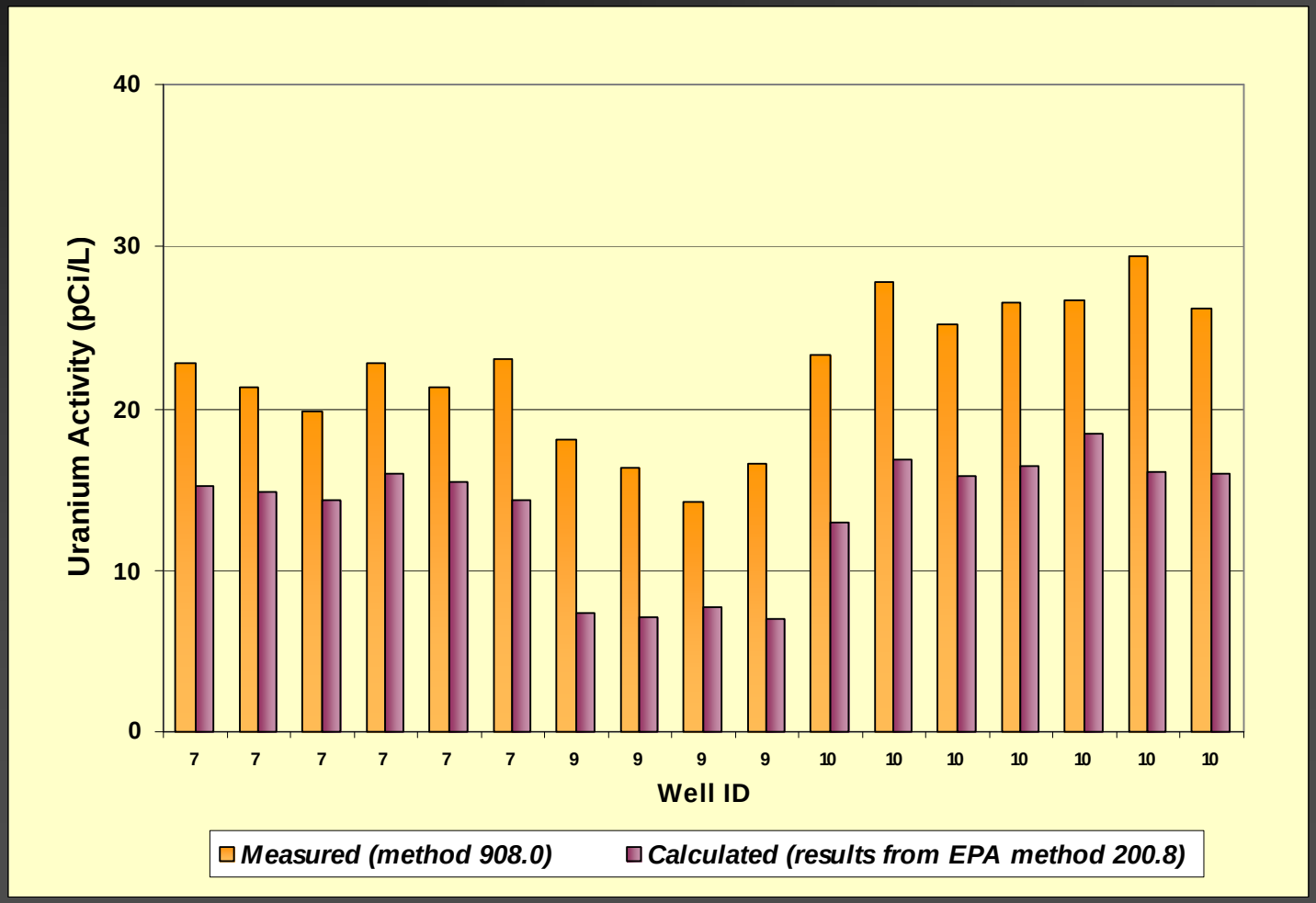
EPA Mandated Conversion for U Mass to Activity

- Based on 1:1 activity ratio of U-234 and U-238, characteristic of naturally-occurring U
- Some ground waters don't follow 1:1 ratio and are enriched in U-234
- U-234 many times more radioactive than U-238, conversion based on mass can underestimate the U activity contribution to the alpha particle activity
- Result = apparent violation of alpha particle MCL

Poolesville Water Supply

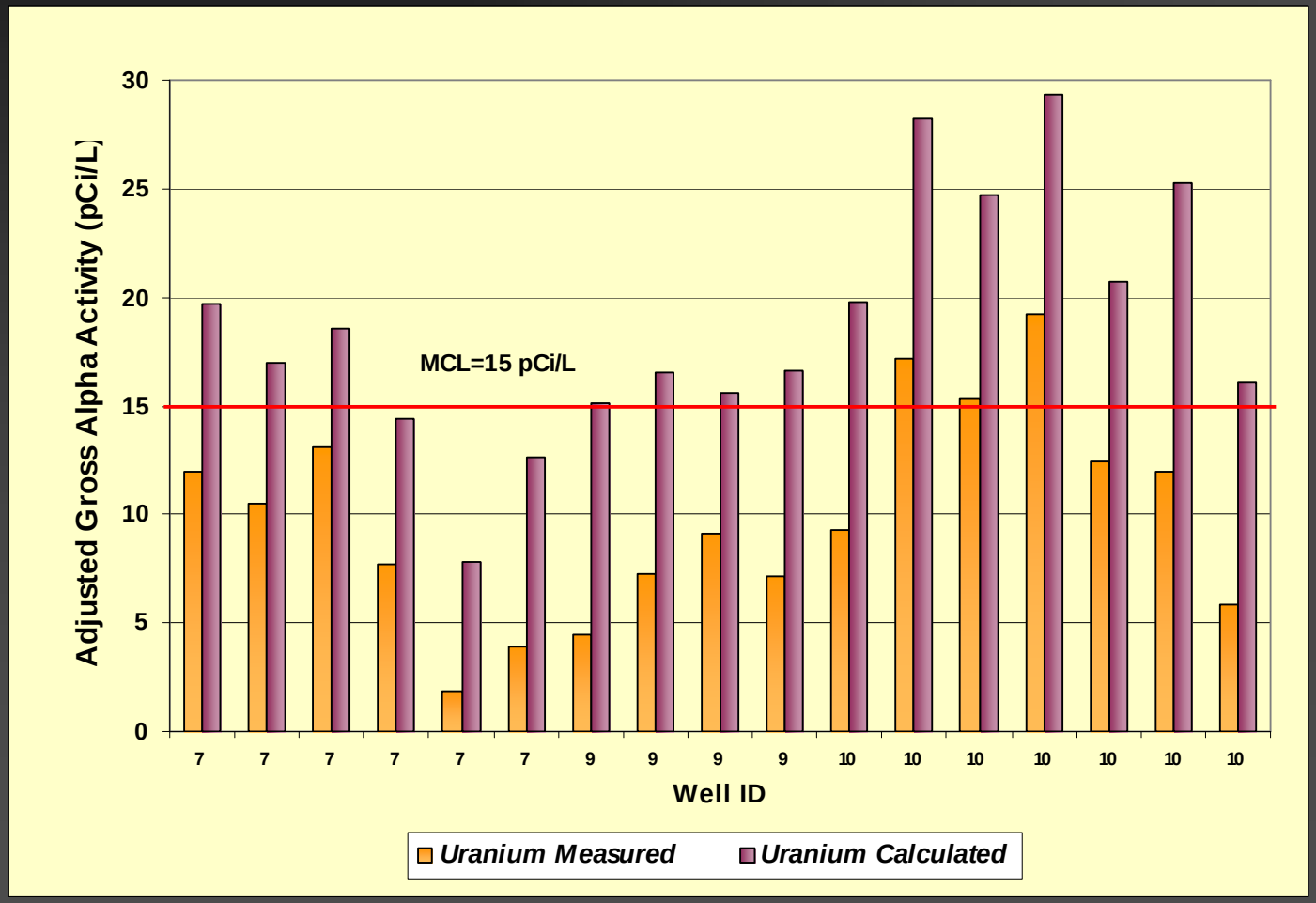
- Ten bedrock wells in Triassic siltstone/sandstone in western Montgomery County, MD
- MDE sampling indicated potential alpha particle violation
- Town conducted quarterly sampling since 2006

Poolesville – Measured vs. Calculated Uranium Activity



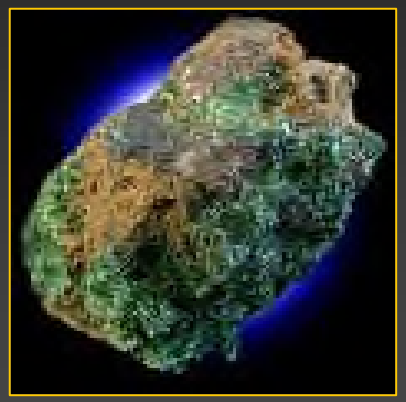
- Average increase of 72% when measure U activity directly

Poolesville – Adjusted Gross Alpha Activity



- All wells in compliance vs. no wells in compliance

Uranium MCL for Drinking Water



- 30 ug/L
- Based on U mass rather than activity
- If use U activity data from Gross Alpha evaluation, must use EPA conversion factor to calculate U mass

Uranium Activity to Mass Conversion

- EPA conversion factor based on assumption of 1:1 activity ratio of U-234 to U-238
- If groundwater enriched in U-234, then conversion overestimates uranium mass
- May result in apparent violation of U MCL

Poolesville Wells – Uranium Concentration

- Average decrease of 40% when measure U concentration directly
- All wells in compliance vs. only 1 in compliance

Conclusions –

- Aquifer conditions can result in disequilibrium in uranium isotopes
- In these case, EPA-mandated conversion factors can overestimate uranium concentration and adjusted gross alpha activity
- Careful selection of analytical methods can avoid apparent violations of MCL

Recommendations – Adjusted Gross Alpha > MCL

- If adjusted gross alpha activity > 15 pCi/L, use a radiochemical analytical method to measure uranium activity directly
- Suggest EPA method 908.0 for U activity
- Do not use converted U data from method 200.8

Recommendations – Uranium Concentration > MCL

- If Uranium concentration exceeds MCL of 30 ug/L, be sure to measure uranium mass directly
- Suggest EPA method 200.8 (ICP-MS)
- Do not use converted U data from method 908.0

Analytical Protocol - Poolesville

- Use NJ 48-hour rapid gross alpha method for gross alpha analyses*
  - Modified method 900.0
  - Requires initial count w/in 36 to 48 hours of sample collection
  - Conduct recount 56 to 76 hours after initial count
- For Uranium –
  - Method 200.8 for uranium mass (ug/L)
  - Method 908.0 for uranium activity (pCi/L)

* *N.J.A.C. 7:9E*